WHAT IS CLAIMED IS:

1. An optical-spectrum flattening method characterized by comprising:

a first step of obtaining a discrete spectrum of a mode spacing Δf using an output light obtained by modulating an amplitude or phase of a continuous wave (CW) output from a single-wavelength light source using a repetition frequency Δf, or an output light output from a pulse light source or an optical pulse output circuit for outputting a pulsed light of the repetition frequency Δf; and

a second step of modulating said discrete spectrum of the mode spacing Δf by frequency Ω when a band of said discrete spectrum is 2fm.

2. An optical-spectrum flattening method according to claim 1, characterized in that:

the repetition frequency Δf and a light of a pulse width (full width at half maximum) t0 have a relationship $t0 \ll (1/\Delta f)$, the pulse width (full width at half maximum) of a light pulse is expanded.

3. An optical-spectrum flattening method according to claim 2, characterized in that:

the pulse width (full width at half maximum) of a light pulse is expanded using a dispersive medium.

~~4. An optical-spectrum flattening method according to any of claims 1 to 3, characterized in that:~~

~~during said second step, a modulator is used which modulates an amplitude or phase of a temporal waveform composed of said discrete optical spectrum.~~

5. An optical-spectrum flattening method according to claim 4, characterized in that:

said modulator for modulating the amplitude or phase is driven by a signal voltage output from an oscillator at a particular frequency.

6. An optical-spectrum flattening method according to claim 5, characterized in that:

the signal voltage from said oscillator is a sinusoidal wave.

7. An optical-spectrum flattening method according to claim 5, characterized in that:

if a phase modulator is used during said second step, a frequency shift of said discrete spectrum is regulated by varying a modulation index.

8. An optical-spectrum flattening method according to claim 5, characterized in that:

the frequency shift of said discrete spectrum is

regulated by causing a multiplier or a divider to multiply or divide an output signal from the oscillator to varying a modulated frequency thereof.

9. An optical-spectrum flattening method according to claim 5, characterized in that:

during said second step, level deviations among modes are regulated by causing the phase modulator to shift a phase of a modulating signal for driving the modulator.

10. An optical-spectrum flattening method according to claim 4, characterized in that:

a combination of a modulator A for modulating the amplitude or phase of said continuous wave (CW) output from said single-wavelength light source and a modulator B for modulating an amplitude or phase of a modulated wave from the modulator A is used in all cases.

11. An optical-spectrum flattening apparatus characterized by comprising:

first means for obtaining a discrete spectrum of a mode spacing Δf using an output light obtained by modulating an amplitude or phase of a continuous wave (CW) output from a single-wavelength light source using a repetition frequency Δf, or an output light output from a pulse light source or an optical pulse output circuit for outputting a pulsed light of the repetition frequency

Δf; and

second means for modulating said discrete spectrum of the mode spacing Δf with a frequency Ω, while $\Omega < 2fm$, when a band of said discrete spectrum is 2fm.

12. An optical-spectrum flattening apparatus according to claim 11, characterized in that:

the repetition frequency Δf and a light of a pulse width (full width at half maximum) t0 have a relationship $t0 \ll (1/\Delta f)$, the pulse width (full width at half maximum) of a light pulse is expanded.

13. A multi-wavelength generating apparatus for modifying an incident light of a single central wavelength using a signal voltage of a predetermined period to thereby generate a multi-wavelength light of plural central wavelengths, the apparatus comprising:

a modulating section having a plurality of optical paths coupled together in series and including one to which said incident light is input, and one or more optical modulating means arranged at predetermined locations in said plurality of optical paths; and

voltage applying means for independently regulating said signal voltage and applying the voltage to input ports of said optical modulating means of said modulating section.

14. A multi-wavelength generating apparatus according to claim 13, characterized in that:

an optical amplifier are provided in the optical path from which at least the multi-wavelength signal is output.

15. A multi-wavelength generating apparatus according to claim 13, characterized in that:

at least one of said optical modulating means is an amplitude modulator.

16. A multi-wavelength generating apparatus according to claim 15, characterized in that:

said modulating section comprises optical modulating means that are separate from said at least one amplitude modulator of said optical modulating means, at least one of the separate optical modulating means is a phase modulator or a phase modulator which concurrently performs phase modulation and amplitude phase modulation, and the remaining means are all amplitude modulators or phase modulators.

17. A multi-wavelength generating apparatus according to claim 15, characterized in that:

said at least one amplitude modulator also operates as a phase modulator.

18. A multi-wavelength generating apparatus according to

claim 17, characterized in that:

said modulating section further comprises an amplitude modulator or a phase modulator.

19. A multi-wavelength generating apparatus according to claim 16 or 18, characterized in that:

said modulating section linearly modulates the phase of the incident light of the single wavelength relative to a signal voltage waveform applied to said input ports of said optical modulating means,

said predetermined period is composed of an increase period corresponding to a half continuous period of said signal voltage and in which the signal voltage increases monotonously and a decrease period corresponding to the remaining half continuous period and in which the signal voltage decreases monotonously in a manner such that the monotonous increase and decrease are symmetrical, and

said amplitude modulator gates said signal voltage waveform individually during said increase period and during said decrease period.

20. A multi-wavelength generating apparatus according to claim 16 or 18, characterized in that:

said modulating section linearly modulates the phase of the incident light of the single wavelength relative to a signal voltage waveform applied to said input port of said optical modulating means,

said predetermined period is composed of an increase period corresponding to a half continuous period of said signal voltage and in which the signal voltage increases monotonously and a decrease period corresponding to the remaining half continuous period and in which the signal voltage decreases monotonously in a manner such that the monotonous increase and decrease are symmetrical, and

said amplitude modulator gates said signal voltage waveform with predetermined timings that span across said increase period and said decrease period.

21. A multi-wavelength generating apparatus according to any of claims 13 to 18, characterized in that:

said plurality of optical paths inside said modulator further have a plurality of optical paths coupled together in parallel, said optical modulating means are arranged in at least one of said plurality of parallel optical paths, and said plurality of optical paths cooperate in performing an amplitude modulating operation.

22. A multi-wavelength generating apparatus according to claim 21, characterized in that:

said optical modulating means are each a Mach-Zehnder intensity modulator which is configured such that said plurality of parallel paths branch one of the optical paths in said modulating section into two portions and then combine them together, the optical modulating means being

arranged in at least one of the branched paths, said branched paths cooperating with each other in performing an amplitude modulating operation.

23. A multi-wavelength generating apparatus according to claim 22, characterized in that:

said optical modulating means comprise one Mach-Zehnder intensity modulator.

Sub A3 cont

24. A multi-wavelength generating apparatus according to any of claims 13 to 18, characterized in that:

said optical modulating means are EL (Electro-Absorption) intensity modulators.

25. A multi-wavelength generating apparatus according to any of claims 13 to 18, characterized by further comprising bias means for applying a bias to said modulating means while independently varying a power thereof.

26. A multi-wavelength generating apparatus according to any of claims 13 to 18, characterized in that:

said modulating section comprises two optical modulating means including an amplitude modulator and a phase modulator.

27. A multi-wavelength generating apparatus according to any of claims 13 to 18, characterized by further comprising

means for multiplying said signal voltage of the predetermined period, and in that:

at least one of said plurality of voltage applying means regulates said multiplied signal voltage and the regulated voltage is then applied to said modulating section.

28. A multi-wavelength generating apparatus according to any of claims 13 to 18, characterized by further comprising signal generating means for generating said signal voltage of the predetermined period as a sinusoidal wave.

29. A multi-wavelength generating apparatus according to any of claims 13 and 14, characterized in that:

said optical modulating means are all optical phase modulators,

said sinusoidal signal voltages are each regulated so that a sum thereof is substantially 1.0π or 1.4π in terms of a phase modulation index.

30. A multi-wavelength generating apparatus according to any of claims 13 to 18, characterized by further comprising signal generating means for generating said signal voltage of the predetermined period as a predetermined temporal waveform signal.

31. A multi-wavelength generating apparatus according to

~~any of claims 13 to 18, characterized in that:~~

Sub A3

~~phase adjusting means for adjusting temporal positions of said independently regulated signal voltages is provided in one of said plurality of voltage applying means.~~

32. A multi-wavelength generating apparatus according to claim 25, characterized by comprising:

first branching means arranged at an input position of said modulating means, for branching said incident light;

second branching means for inputting said branched incident light falling thereon, to said modulating means, and outputting an output light from said modulating means to a following component;

monitor means for monitoring said branched incident light which has entered said first branching means via said modulating means; and

means for controlling a bias applied to said modulating means entered by said branched incident light, on the basis of a result of said monitoring.

33. A multi-wavelength generating apparatus according to claim 25, characterized by further comprising:

branching means arranged at an output position of said modulating means, for branching an output light from said modulating means;

means for monitoring said branched output light; and

means for controlling a bias to be applied to said modulating means having output said output light, on the basis of a result of said monitoring.

34. A multi-wavelength generating apparatus according to any of claims 25, characterized by further comprising:

a first branching means located at an input of said modulating means for branching said input light into a signal light and a monitoring light,

a second branching means inputted said signal light through said modulating means thereto for branching output light through said modulating means into the signal light and another monitoring light,

means for photo-electrically converting a power level of said monitoring light into a first electrical signal,

means for photo-electrically converting a power level of said another monitoring light into a second electrical signal, and

means for supplying a bias voltage based on said first and second electrical signal to said modulating means so as to constantly maintain the ratio of said signal light at said input and output of said modulating means.

35. A multi-wavelength generating apparatus according to any of claims 13 to 18, characterized by further comprising multiplexing means for multiplexing a plurality of

incident lights of different single central wavelengths and allowing said multiplexed light to fall on a first optical modulating means of said modulating section.

36. A multi-wavelength generating apparatus according to claim 35, characterized in that:

said plurality of incident lights have frequencies thereof arranged at predetermined intervals,

said multiplexing means has first multiplexing means for allowing every other of said plural incident lights on a frequency axis to be entered for multiplexing, and second multiplexing means for allowing the remaining every other of said plural incident lights to be entered for multiplexing,

said modulating section has a first modulating section for modulating said multiplexed light from said first multiplexing means and a second modulating section for modulating said multiplexed light from said second multiplexing means, and further comprises:

first multiplexing and demultiplexing means for demultiplexing an output light from said first modulating section into said different signal central wavelengths and multiplexing these wavelengths,

second multiplexing and demultiplexing means for demultiplexing an output light from said second modulating section into said different signal central wavelengths and multiplexing these wavelengths, and

means for multiplexing a multiplexed light provided by said first multiplexing and demultiplexing means and having said every other component and a multiplexed light provided by said second multiplexing and demultiplexing means and having said remaining every other component.

37. A multi-wavelength generating apparatus according to claim 36, characterized in that:

said first modulating section generates side mode lights at an output thereof in a manner such that the optical powers of (2N + m) (N is a natural number, and m is an integer) wavelengths fall within a predetermined range, and

said second modulating section generates side mode lights at an output thereof in a manner such that the optical powers of (2N - m) (N is a natural number, and m is an integer) wavelengths fall within a predetermined range.

38. A coherent multi-wavelength signal generating apparatus characterized by comprising:

a multi-wavelength light source for generating a multi-wavelength light having a plurality of wavelength components;

a demultiplexer for separating said multi-wavelength light into different wavelengths;

an optical modulator for modulating coherent lights

of the different wavelengths obtained by said demultiplexer, using a transmitted signal;

a multiplexer for multiplexing modulated signal lights modulated by said optical modulator and outputting a coherent multi-wavelength signal; and

control means for controlling a shape of a spectrum of the multi-wavelength light output from said multi-wavelength light source so that a relative intensity noise RIN(i) from an i-th wavelength component obtained by spectrum slicing executed by said multiplexer meets the following equations:

$$RIN(i) = RIN + 10Log_{10}(Pi/\Sigma Pi)$$
$$RIN = -\gamma - 10log_{10}BW_{SE} + 3$$
$$\gamma = 10log_{10}(P_{LAS}/P_{SE})$$

when a relative intensity noise for said multi-wavelength light source is defined as RIN[dB/Hz], a ratio of a probability of stimulated emission to that of spontaneous emission is defined as γ[dB], a stimulated emission light intensity is defined as P_{LAS}[dBm], a spontaneous emission light intensity is defined as P_{SE}[dBm], a spontaneous emission light band is defined as BW_{SE}[Hz], and a light intensity of the i-th wavelength component is defined as Pi.

39. A coherent multi-wavelength signal generating

apparatus characterized by comprising:

a multi-wavelength light source for generating a multi-wavelength light having a plurality of wavelength components;

a demultiplexer for separating said multi-wavelength light into different wavelengths;

an optical modulator for modulating coherent lights of the different wavelengths obtained by said demultiplexer, using a transmitted signal;

a multiplexer for multiplexing modulated signal lights modulated by said optical modulator and outputting a coherent multi-wavelength signal;

an optical amplifier for amplifying said multi-wavelength light output from said multi-wavelength light source and inputting the amplified multi-wavelength light to said multiplexer; and

control means for controlling a shape of a spectrum of the multi-wavelength light output from said multi-wavelength light source so that a relative intensity noise RIN(i) from an i-th wavelength component obtained by spectrum slicing executed by said multiplexer meets the following equations:

$$RIN(i) = RIN+10Log_{10}(Pi/\Sigma Pi)$$

$$RIN = -\gamma-10\log_{10}BW_{SE}+3$$

$$\gamma = 10\log_{10}[gP_{LAS}/\{gP_{SE}(BW_{SE}/BW_{AMP})+ h\nu(g-1)n_{sp}\bullet m\bullet BW_{AMP}\}]$$

when a gain of said optical amplifier is defined as g, an optical amplifying band is defined as BW_{AMP}[Hz], the total number of lateral modes is defined as m, a population inversion parameter is defined as n_{sp}, and a central optical frequency of said multi-wavelength light source is defined as ν[Hz].

40. A coherent multi-wavelength signal generating apparatus according to claim 38 or 39, characterized in that:

Sub A5 Cont

when a band of a receiver is defined as Be[Hz], a demultiplexing band of a demultiplexer located before the receiver is defined as B_0[Hz], a signal mark rate is defined as M, a signal light intensity of an output from an i-th modulator is defined as P(i)[dBm], an intensity of a stimulated emission light in the output from this modulator is defined as Pc(i)[dBm], an intensity of a spontaneous emission light in the output from this modulator is defined as Ps(i)[dBm], an equivalent current flowing through said receiver is defined as Ieq[A], shot noise in signal components is defined as Ns, beat noise between the signal components and a spontaneous emission light is defined as Ns-sp, beat noise between spontaneous emission lights is defined as Nsp-sp, and thermal noise from said receiver is defined as N_{th}, said control means controls the shape of the spectrum of the multi-wavelength light output from

said multi-wavelength light source so that a signal-to-noise ratio SNR for outputs from said modulators meets the following equations:

$$SNR = S/(Ns + Ns\text{-}sp + Nsp\text{-}sp + N_{th})$$
$$Ps(i) = RIN(i) + 10\log_{10}Be + Pc(i) + 10\log_{10}M$$
$$S = ((e\eta/h\nu)Pc(i))^2$$
$$Ns = 2e((e\eta/h\nu)P(i))Be$$
$$Ns\text{-}sp = 4(e\eta/h\nu)^2 Pc(i)Ps(i)Be/Bo$$
$$N_{th} = Ieq^2 Be$$

where P(i), Pc(i), and Ps(i) in S, Ns, and Ns-sp are expressed in W using a linear notation.

41. A coherent multi-wavelength signal generating apparatus according to claim 38 or 39, characterized in that:

when a band of a receiver is defined as Be[Hz], a demultiplexing band of a demultiplexer located before the receiver is defined as B_0[Hz], a signal mark rate is defined as M, a signal light intensity of an output from an i-th modulator is defined as P(i)[dBm], a intensity of a stimulated emission light in the output from this modulator is defined as Pc(i)[dBm], an intensity of a spontaneous emission light in the output from this modulator is defined as Ps(i)[dBm], an equivalent current flowing through the receiver is defined as Ieq[A], a rate of leakage from a

j-th port to an i-th port of said multiplexer is defined as XT(i), a light intensity of a cross talk signal from said multiplexer is defined as Px(i)[dBm], shot noise in signal components is defined as Ns, beat noise between the signal components and the spontaneous emission light is defined as Ns-sp, beat noise between the signal components and the cross talk signal light is defined as Ns-x, beat noise between spontaneous emission lights is defined as Nsp-sp, beat noise between the cross talk signal light and the spontaneous emission light is defined as Nx-sp, and thermal noise from said receiver is defined as N_{th};

said control means controls the shape of the spectrum of the multi-wavelength light output from said multi-wavelength light source so that a signal-to-noise ratio SNR for outputs from said modulators meets the following equations:

$$SNR = S/(Ns + N_{s\text{-}sp} + N_{x\text{-}sp} + N_{sp\text{-}sp} + N_{s\text{-}x} + N_{th})$$

$$Ps(i) = RIN(i) + 10\log_{10}Be + Pc(i)10\log_{10}M$$

$$Px(i) = \Sigma P(j) \bullet XT(j)$$

$$S = ((e\eta/h\nu)Pc(i))^2$$

$$Ns = 2e((e\eta/h\nu)P(i))Be$$

$$N_{s\text{-}sp} = 4(e\eta/h\nu)^2 Pc(i)Ps(i)Be/Bo$$

$$N_{x\text{-}sp} = 4(e\eta/h\nu)^2 Px(i)Ps(i)Be/Bo$$

$$N_{s\text{-}x} = (e\eta/h\nu)^2 Pc(i)Px(i)$$

$$N_{th} = Ieq^2 Be$$

where P(i), Pc(i), and Ps(i) in S, Ns, and Ns-sp are expressed in W using a linear notation.

42. A coherent multi-wavelength signal generating apparatus according to claim 38 or 39, characterized in that:

said multi-wavelength light source comprises a light source for generating a light having a single central wavelength and an optical modulator for modulating an intensity or phase of an output light from the light source using a predetermined period signal, to generate a multi-wavelength light, and

said control means regulates at least one of a voltage of said period signal and a bias voltage at said optical modulator so as to control a shape of an optical spectrum of the multi-wavelength light generated by said multi-wavelength light source.

43. A coherent multi-wavelength signal generating apparatus according to claim 42, characterized in that:

said control means controls phases of said period signals to control the shape of the spectrum of the multi-wavelength light generated by said multi-wavelength light source.

44. A coherent multi-wavelength signal generating apparatus according to claim 42, characterized in that:

said control means controls multiplier factors for said period signals to control the shape of the spectrum of the multi-wavelength light generated by said multi-wavelength light source.

45. A multi-wavelength light for generating a plurality of optical carriers of different wavelengths from a plurality of input lights of different central wavelengths, characterized by comprising:

first multiplexing means for multiplexing those of said plurality of input lights which have an odd-number-th wavelength;

second multiplexing means for multiplexing those of said plurality of input lights which have an even-number-th wavelength;

first modulating means for modulating an output light from said first multiplexing means;

second modulating means for modulating an output light from said second multiplexing means;

polarization multiplexing means for combining outputs from said first and second modulating means with orthogonal polarization; and

separating means for separating a synthesized multi-wavelength output from said polarization multiplexing means, into said optical carriers of different wavelengths.

46. A multi-wavelength light according to claim 45, characterized in that:

said first modulating section generates side mode lights at an output thereof in a manner such that the optical powers of (2N + m) (N is a natural number, and m is an integer) wavelengths fall within a predetermined range, and

said second modulating section generates side mode lights at an output thereof in a manner such that the optical powers of (2N - m) (N is a natural number, and m is an integer) wavelengths fall within a predetermined range.

47. A multi-wavelength light for generating a plurality of optical carriers of different wavelengths from a plurality of input lights of different central wavelengths, characterized by comprising:

first multiplexing means for multiplexing those of said plurality of input lights which have an odd-number-th wavelength;

second multiplexing means for multiplexing those of said plurality of input lights which have an even-number-th wavelength;

polarization multiplexing means for combining a multiplexed output from said first multiplexing means and a multiplexed output from said second multiplexing means so that those outputs are combined with orthogonal

polarization;

modulating means for modulating an output light from said polarization multiplexing means; and

separating means for separating a modulated multi-wavelength output from said modulating means, into said optical carriers of different wavelengths.

48. A multi-wavelength light according to claim 45 or 47, characterized in that:

said first and second modulating means/said modulating means executes such modulations that side modes are output so that the optical powers of output wavelengths at outputs of said polarization multiplexing means/said modulating means are substantially equal.

49. A multi-wavelength light according to claim 48, characterized in that:

said modulating means outputs side modes so that those of the side modes of an output light corresponding to said plurality of adjacent input lights which are each located between each of adjacent input optical wavelengths and a substantially intermediate wavelength between said input optical wavelengths have a substantially fixed optical power, and side modes of the same wavelength, that is, said substantially intermediate wavelength, have substantially half of said fixed optical power.